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Central tarsal bone fractures in horses not used for racing: Computed tomographic configuration and long-term outcome of lag screw fixation

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Abstract: REASONS FOR PERFORMING STUDY: There are no reports on the configuration of equine central tarsal bone fractures based on cross-sectional imaging and clinical and radiographic long-term outcome after internal fixation. OBJECTIVES: To report clinical, radiographic and computed tomographic findings of equine central tarsal bone fractures and to evaluate the long-term outcome of internal fixation. STUDY DESIGN: Retrospective case series. METHODS: All horses diagnosed with a central tarsal bone fracture at our institution in 2009-2013 were included. Computed tomography and internal fixation using lag screw technique was performed in all patients. Medical records and diagnostic images were reviewed retrospectively. A clinical and radiographic follow-up examination was performed at least 1 year post operatively. RESULTS: A central tarsal bone fracture was diagnosed in 6 horses. Five were Warmbloods used for showjumping and one was a Quarter Horse used for reining. All horses had sagittal slab fractures that began dorsally, ran in a plantar or plantaromedial direction and exited the plantar cortex at the plantar or plantaromedial indentation of the central tarsal bone. Marked sclerosis of the central tarsal bone was diagnosed in all patients. At long-term follow-up, 5/6 horses were sound and used as intended although mild osteophyte formation at the distal intertarsal joint was commonly observed. CONCLUSIONS: Central tarsal bone fractures in nonracehorses had a distinct configuration but radiographically subtle additional fracture lines can occur. A chronic stress related aetiology seems likely. Internal fixation of these fractures based on an accurate diagnosis of the individual fracture configuration resulted in a very good prognosis.

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Central tarsal bone fractures in horses not used for racing: computed tomographic configuration and long-term outcome of lag screw fixation

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Summary

Reasons for performing study: There are no reports on the configuration of equine central tarsal bone fractures based on cross-sectional imaging and clinical and radiographic long-term outcome after internal fixation.

Objectives: To report clinical, radiographic and computed tomographic findings of equine central tarsal bone fractures and to evaluate the long term outcome of internal fixation.

Study design: Retrospective case series.

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Methods: All horses diagnosed with a central tarsal bone fracture at our institution between 2009–2013 were included. Computed tomography and internal fixation using lag screw technique was performed in all patients. Medical records and diagnostic images were reviewed retrospectively. A clinical and radiographic follow-up examination was performed at least one year postoperatively.

Results: A central tarsal bone fracture was diagnosed in 6 horses. Five were Warmbloods using for showjumping and one was a Quarter Horse used for reining. All horses had sagittal slab fractures that began dorsally, ran in a plantar or plantaromedial direction and exited the plantar cortex at the plantar or plantaromedial indentation of the central tarsal bone. Marked sclerosis of the central tarsal bone was diagnosed in all patients. At long term follow-up, 5/6 horses were sound and used as intended although mild osteophyte formation at the distal intertarsal joint was commonly observed.

Conclusions: Central tarsal bone fractures in non-racehorses had a distinct configuration but radiographically subtle additional fracture lines can occur. A chronic stress related aetiology seems likely. Internal fixation of these fractures based on an accurate diagnosis of the individual fracture configuration resulted in a very good prognosis.

Introduction

Central tarsal bone fractures are uncommon [1, 2]. They usually occur in racehorses racing or training at high speeds and are reported more often in Standardbreds than in other breeds [2, 3]. Lameness is moderate to severe initially and then diminishes to mild or moderate within two weeks [2, 4]. Mild focal swelling and effusion of the talocrural joint can often be noted [3]. Central tarsal bone fractures are difficult to

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diagnose radiographically and can sometimes be undetected on initial radiographic examination. Bone scintigraphy can allow early diagnosis [5].

Central tarsal bone fractures are mostly described as slab fractures oriented in the frontal plane at the dorsal or dorsolateral aspect that can be best identified on lateromedial or slightly oblique radiographs [3, 4]. Central tarsal bone fractures are often more complex and can have additional fracture lines that may be missed radiographically [1, 2].

There is no detailed description of the configuration of equine central tarsal bone fractures based on cross-sectional imaging and there is very little information available on nonracing breeds. A detailed understanding of the fracture configuration is required for successful surgical repair [1]. Outcome post internal fixation of central tarsal bone fractures has only been reported in racehorses and relied on telephone interview and racing records only [3]. The objectives of this study were to: 1) report clinical and radiographic findings of central tarsal bone fractures in a population of horses not used for racing, 2) describe the exact configuration of these fractures using computed tomography (CT) and 3) evaluate outcome of internal fixation based on clinical and radiographic long term follow-up examination.

Materials and methods

All horses diagnosed with a central tarsal bone fracture and absence of complex tarsal injuries, i.e. fractures of multiple tarsal bones, at the Equine Hospital of the University of Zurich between 2009 and 2013 were included in the study. All patients underwent CT

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examination and internal fixation. Clinical and radiographic examinations were repeated at least one year after surgery in all horses and included an owner questionnaire (Supplementary Item 1) and clinical and radiographic examinations.

Clinical and radiographic examinations including dorsoplantar (DP), lateromedial (LM), dorsomedial-plantarolateral oblique (DMPLO) and dorsolateral-plantaromedial oblique (DLPMO) projections of the tarsus were performed in all cases before and after surgery and at the follow-up examination.

CT examinations were performed with horses in lateral recumbency under general anaesthesia using a multi-slice helical CT scanner[a]. Continuous transverse images were acquired in a helical fashion and reconstructed to a slice thickness of 0.75 mm applying a bone algorithm and to a slice thickness of 1.5 mm with a soft tissue algorithm. CT images were reviewed using multiplanar reconstruction. All radiographs and CTs were evaluated by a board-certified radiologist (F.D.C.).

Surgery was performed immediately after CT under the same general anaesthesia. Horses were placed in lateral recumbency with the affected limb down. Implant position was planned based on CT images and skin staples were placed as markers under CT control to indicate the location of screw insertion. One or two 3.5 or 4.5 mm cortical screws[b] were inserted in lag fashion [6] via stab incisions into a bicortical drill hole created under fluoroscopic control. After closure of subcutaneous tissues and skin, a bandage was applied and an assisted recovery using head and tail ropes was performed. All horses received prophylactic perioperative antimicrobial therapy before and until 1 – 3 days after surgery. Non-steroidal anti-inflammatory drugs were administered before surgery and 4 – 8 days postoperatively. Horses were confined to a

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stable for 4 weeks after surgery followed by 3 months of walking exercise. An examination by the referring veterinarian was recommended after this with a gradual increase in exercise over the next 3 months provided that the horse was sound at the walk and trot and there were no complications.

Results

History and signalment

Six horses were included in the study (Supplementary Item 2), 5 Warmbloods and one Quarter Horse, 4 geldings, one stallion and one mare with a median age of 8.5 years (range 6 – 11 years) and median body weight of 550 kg (range 460 – 640 kg). All Warmblood horses were used for showjumping. The Quarter horse was used for reining.

The onset of lameness was during or immediately after jumping competition in 3 Warmblood horses and in the box or on pasture in 2 other Warmbloods. Duration of lameness before presentation to the hospital varied between 1 – 33 days in the Warmbloods. The Quarter Horse had a history of a chronic lameness after a fall 3 years previously and had been treated with intraarticular corticosteroid therapy of the tarsometatarsal (TMT) and distal intertarsal (DIT) joints 2.5 months before presentation to the hospital after degenerative changes were identified radiographically by the referring veterinarian.

Clinical and radiographic findings at initial examination

Lameness varied in severity from mild to severe and the left hindlimb was affected in 2 horses and the right hindlimb in 4 horses (Supplementary Item 2). Perineural

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anaesthesia of the peroneal and tibial nerve, intra-articular anaesthesia of the TMT or talocrural joint resulted in marked improvement of lameness when it was performed in 5 horses. Effusion of the talocrural joint was noted in 4/6 horses. Hemarthrosis was evident in the 2 horses that underwent arthrocentesis of the talocrural joint (Supplementary Item 2).

Radiographically, a subtle radiolucent line within the central tarsal bone was identified in all Warmblood horses. This fracture line was visible on the DP projection only in 2 horses, on both the DP and LM projection in one horse (No. 2) and on the DMPLO view only in 2 horses. All fractures were non-displaced and difficult to identify on radiographs (Fig 1). One horse (No. 2) had mild new bone formation at the dorsal aspect of the central tarsal bone. Another horse (No. 5) had mild sclerosis and joint space narrowing of the TMT joint indicating mild osteoarthritis (OA). In the Quarter horse with chronic lameness, moderate OA of the DIT joint was evident but no fracture lines were identified. All horses had sclerosis of the central tarsal bone that ranged from mild to severe.

Computed tomography

A very consistent fracture pattern was identified with CT. All horses had sagittal slab fractures that began dorsally, extended in a plantar or plantaromedial direction and exited the plantar cortex at the plantaromedial indentation of the central tarsal bone (located just medially to the articular surface to the fused first and second tarsal bone) in 5 horses (Fig 2) or at the plantar indentation between the two small articular surfaces to the fourth tarsal bone in the other horse (Fig 3). An additional fracture line was present in patient No. 2, which exited at the lateral cortex and resulted in a Y-

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shaped fracture configuration. Moderate to severe sclerosis of the central tarsal bone was present in all horses. All fractures were non-displaced. Only horse No. 6 had mild sclerosis of the third tarsal bone (Supplementary Item 3).

Surgery

One 4.5 mm cortical screw[b] was inserted in 4 horses (No. 3, 4, 5 and 6). Two 4.5 mm cortical screws[b] were implanted in one horse (No. 2) and the other horse (No. 1) was treated with one 4.5 mm cortical screw[b] and one 3.5 mm cortical screw[b]. All screws were inserted principally in a medial to lateral direction with angulations from the dorsal plane depending on individual fracture configuration, typically in a plantaromedial-dorsolateral direction. There were no complications associated with surgery and general anaesthesia.

Post-operative clinical and radiographic findings

All horses had very good weight-bearing postoperatively. One horse (No. 6) developed laminitis of both front limbs that resolved following treatment with phenylbutazone, low-molecular weight heparin and hoof bandages. No other complications were noted during hospitalisation.

On postoperative radiographs, the fracture line was still faintly visible in 3 horses (No. 2, 4 and 6) and could not be identified in the other 3 horses (No. 1, 3 and 5). Mild bending of the screw was noted in 2 patients (No. 3 and 4).

Horse No. 1 was represented to the hospital 7 months after surgery for evaluation of swelling at the surgical site. The horse was sound at the walk and trot. A focal swelling

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at the surgical site that was not painful on palpation was evident. Radiographically, there was marked new bone formation and soft tissue swelling around the screw heads. Screw removal under general anaesthesia was attempted however, the head of one 3.5 mm cortical screw broke off and the shaft of this screw was left in the bone.

Clinical and radiographic findings at long term follow-up

The mean time to long term follow-up examination was 36.5 months after surgery (range 12 – 54 months). All Warmblood horses had returned to their use for showjumping, 4 performing without any problems while the other had a slight decrease in performance. On examination all Warmblood horses were sound at the walk and trot and there was no talocrural joint effusion. The horse with the history of decreased performance had marked thoracolumbar back pain and radiography demonstrated severe chronic degenerative changes of the thoracolumbar spinous processes.

The Quarter Horse did not return to its previous use due to persistent lameness. This horse was graded as 2/5 lame [7] on the operated limb. Effusion of both femoropatellar joints was noted and intra-articular anaesthesia of the stifle joint improved but did not completely abolish the lameness. Radiographically, bilateral flattening of the medial femoral condyle was evident. All owners reported that they were very satisfied with results of surgery.

On radiography, the fracture line was no longer visible in any of the horses. No implant failure was detected and there was no progressive bending of the screws. Sclerosis of the central tarsal bone was unchanged in 3 horses and mildly progressive in the other 3 horses. Two horses had smoothly delineated mild or moderate new bone formation at

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the surgical site extending from the distal part of the talus to the proximal part of the third tarsal bone. Two other horses had well defined mild new bone formation directly adjacent to a screw head. Mild OA developed in the DIT joint of 3 horses (Fig 4). In the Quarter horse there was slight progression of OA in the DIT joint (Supplementary Item 4).

Discussion

A very consistent configuration of central tarsal bone fractures was found in this population of horses not used for racing. CT is generally considered the gold standard to diagnose fractures and to evaluate their three-dimensional configuration [8]. This is the first study that describes the use of CT to evaluate the configuration of central tarsal bone fractures in the horse.

Radiography is limited both in detection of non-displaced and incomplete fractures and in elucidating fracture configuration [9]. This limitation was demonstrated by case 6 that had no evidence of a central tarsal bone fracture on radiographs but CT demonstrated a clear fracture line in this horse. The exact course of the fractures could not be determined with radiography alone in any of these horses.

The lack of cross-sectional imaging in previous studies impairs comparison of fracture configurations with our cases. However, all previous reports on central tarsal bone fractures in racehorses agree that these horses typically have a slab fracture in the dorsal plane located at the dorsal aspect [2-4] that can be best identified on lateromedial radiographs [2, 4]. In contrast, horses in our study typically had a fracture line in the sagittal plane and this was most often identified with the dorsoplantar radiographic projection. Differences in the stress distribution within the central tarsal

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bone may occur with different athletic activities and this may explain differences in fracture configuration in horses engaged in different sports. While biomechanical studies that evaluate stress distribution have been published for other bones, such as the proximal phalanx, there are none relating to the central tarsal bone [10, 11]. Warmblood horses used for showjumping were overrepresented in this study compared to our hospital population. Marked sclerosis of the central tarsal bone was present in all cases despite the acute nature of the fracture in most horses. These sclerotic changes suggest that was remodelling in response to chronic stress and most likely represent a process of prodromal changes followed by a stress fracture as has been described in other bones of equine athletes [12]. Such sclerotic changes have not been reported with central tarsal bone fractures in racehorses [2-4]. However, OA of the small tarsal joints was noted in half of the patients in one study [4]. In contrast, only one Warmblood horse in this study had mild OA of the TMT joint at admission. Therefore, it seems that OA does not usually accompany acute or subacute fractures of the central tarsal bone in Warmblood horses.

In the Quarter horse, the diagnosis of a fracture was possible only with CT validating our decision to perform CT in this horse in order to complete the diagnostic work-up. This horse had moderate OA of the DIT joint at initial examination but very little new bone formation related to the fracture. Therefore, it is more likely that the fracture occurred secondary to degenerative joint disease than *vice versa*.

The clinical findings in the current horses correspond to previous reports in terms of lameness, talocrural joint effusion and response to diagnostic anaesthesia [1]. The biarticular nature of these fractures makes OA a common sequela and OA of the DIT and PIT joint are the main reason for a poor outcome achieved with conservative therapy of central tarsal bone fractures [2, 4]. Delayed or non-union healing has been reported in

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patients treated conservatively [4]. Surgery is therefore indicated for treatment of fractures of the central tarsal bone. A favourable outcome is expected with 72% of cases returning to racing in racehorses after internal fixation of central or third tarsal bone fractures [3]. Placing one or two 3.5 or 4.5 mm cortical screws in lag fashion is recommended [1, 3]. Additional fracture lines leading to a comminuted or Y-shaped configuration can be present however, and may not be identified on radiographs [2]. Such a Y-shaped fracture pattern was identified via CT in case No. 2 in this study. Undetected fracture lines represent a hazard when attempting internal fixation without performing CT. Furthermore, precise information on individual fracture configuration helps to determine optimal position of the screw and to plan depth of the glide hole. This is well recognised for slab fractures of the small carpal bones where arthroscopy can be used to identify fracture lines and control implant position [13]. However, arthroscopic control is not an option for fractures of the small tarsal bones making CT the modality of choice.

One strength of our study was that all cases had clinical and radiographic long term follow-up examination and this confirmed that fracture healing was consistently achieved. Mild to moderate new bone formation at the surgical site was observed in some horses but was without clinical consequences. Such proliferations restricted to the surgical site should not be interpreted as degenerative joint disease. Mild bony proliferation around the screw head occurred in two horses without any clinical consequences. One horse developed moderate bone proliferation and soft tissue swelling around the screw heads without clinical or radiographic evidence of infection and screw removal after 7 months resolved the problem. Screw removal was similarly required occasionally in racehorses in previous studies [3]. Mild osteophyte formation

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at the DIT joint commonly developed in our horses but was not associated with clinical signs.

In conclusion, this group of central tarsal bone fractures in horses not used for racing were mainly Warmbloods used for showjumping. A chronic stress related etiology seems likely. In this population, fractures of the central tarsal bone have a distinct configuration but additional fracture lines hardly identifiable on radiographs can be present. Internal fixation of these fractures results in a very good prognosis when based on a precise diagnosis of the three-dimensional individual fracture configuration.

Authors' declaration of interests

The authors have declared no competing interests.

Ethical Animal Research

Research ethics committee oversight not currently required by this journal: retrospective study of clinical records. Owners gave informed consent for their horses' inclusion in the study.

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Authorship

S. Gunst contributed to study execution, data analyis and preparation of the manuscript. F. Del Chicca contributed to data analysis and interpretation, and preparation of the manuscript. A.E. Fürst contributed to study design, study execution and data interpretation and J.M. Kuemmerle contributed to study design, study execution, data analysis and interpretation, and preparation of the manuscript. All authors revised and gave their final approval of the manuscript.

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Figure legends

Fig 1: Preoperative dorsoplantar radiograph of the right tarsus of case No. 5 obtained at initial examination. A subtle vertical radiolucent line (arrow) in the central tarsal bone is difficult to identify but indicates presence of a non-displaced fracture.

Fig 2: Transverse CT image (bone window) of the left tarsus of case No. 1 illustrating a typical fracture configuration. Dorsal is on top, medial on the right. A fracture line (black arrow) is running in the sagittal plane through the central tarsal bone (Os tarsi centrale; OTC). This line exits the plantar cortex in the indentation (white arrow) between the articular surface to the fused first and second tarsal bone (I + II) and the articular

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surface to the fourth tarsal bone (IV). Note the marked sclerosis of the central tarsal bone around the fracture line, especially in the dorsal aspect.

Fig 3: Schematic representation of the fracture lines of all cases included in the study. This is a transverse CT section through the central tarsal bone (Os tarsi centrale; OTC). Dorsal is on top, medial on the right. Individual fracture lines are shown in different colours (Yellow: No. 1; White: No. 2; Blue: No. 3; Black: No. 4; Red: No. 5; Green: No. 6). The principal fracture configuration is a sagittal slab fracture. The majority of fracture lines exit the plantar cortex at the indentation (white arrow) between the articular surface to the fused first and second tarsal bone (I+II) and the articular surfaces to the fourth tarsal bone (IV). Only one fracture line exits the plantar cortex between the two articular surfaces to the fourth tarsal bone (white arrowhead). An additional fracture line is present in patient No. 2 and courses in the frontal plane to the lateral cortex.

Fig 4: Dorsomedial-plantarolateral oblique radiograph of the right tarsus of case No. 5 obtained 14 months after surgery. A 50 mm long 4.5 mm cortical screw was inserted in lag fashion in a plantaromedial to dorsolateral direction. The implant is intact. Mild osteophyte formation is evident at the dorsolateral aspect of the distal intertarsal joint (white arrow). This was a common finding at long term follow-up. No other complications are identified. In this horse, slight narrowing of the joint space of the tarsometatarsal joint (white arrowhead) was present preoperatively and remained unchanged over time.

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Supplementary Information

Supplementary Item 1: Owner questionnaire used at the follow-up examination.

Supplementary Item 2: History, signalment and clinical findings of the patients.

Supplementary Item 3: Computed tomography findings.

Supplementary Item 4: Radiographic findings at long term follow-up.

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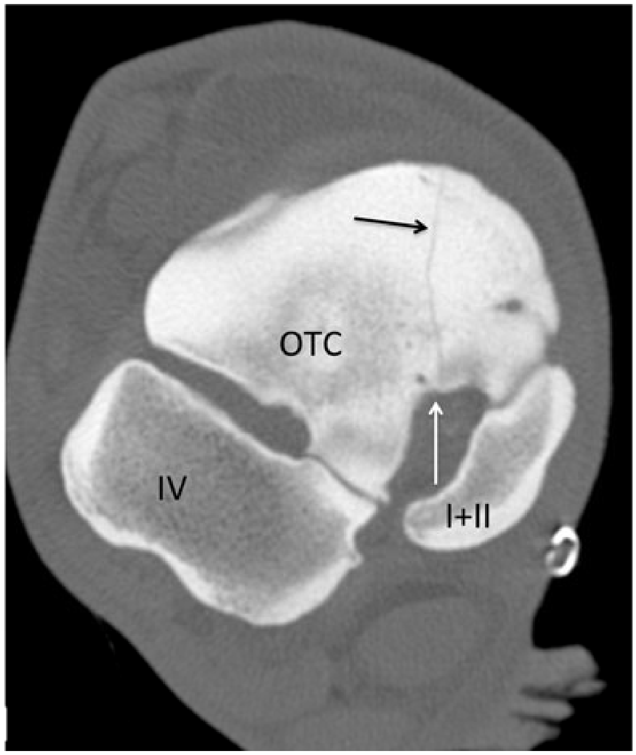

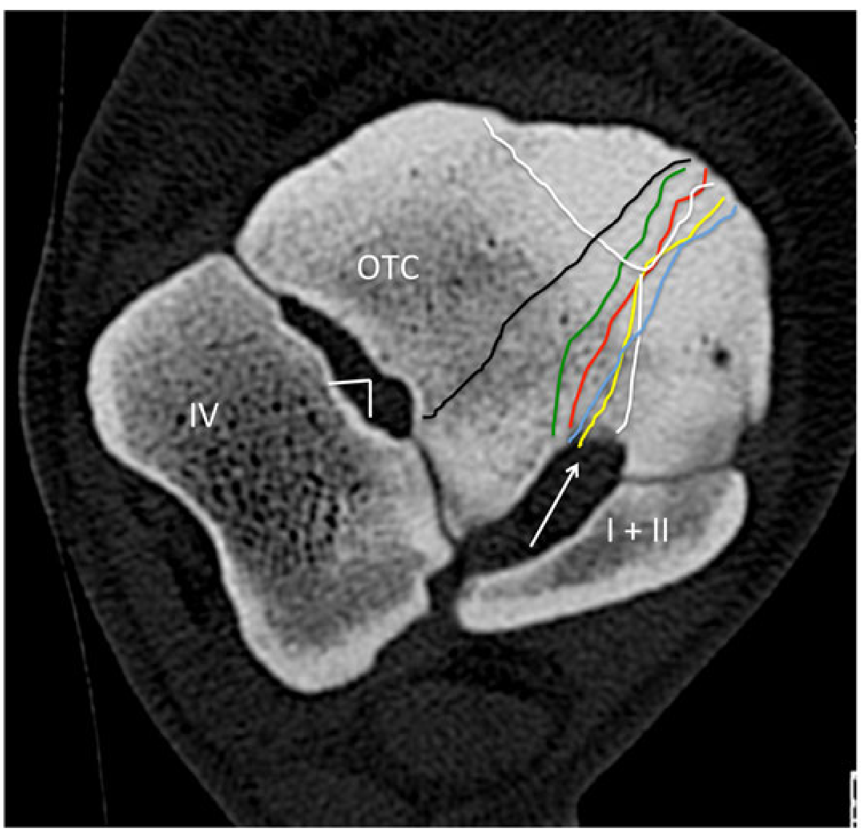

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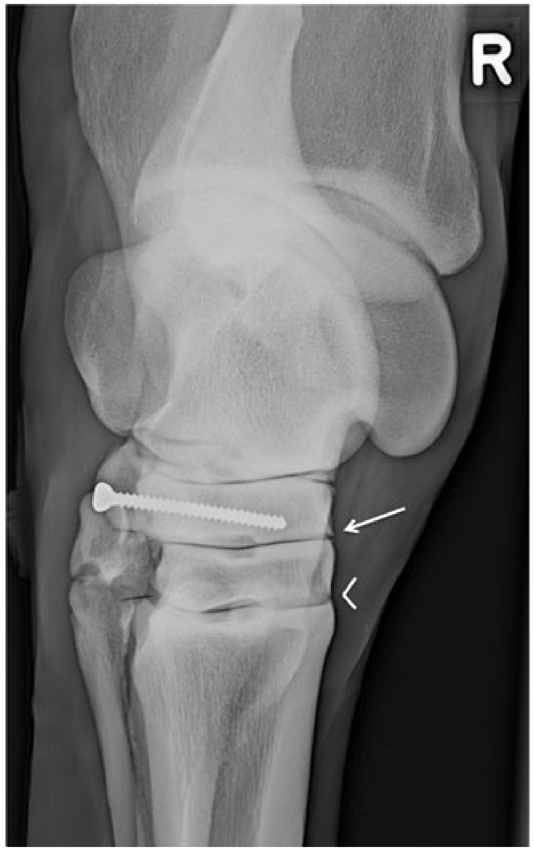

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